

**What Is Claimed Is:**

- 1        1. An electrostatic discharge (ESD) protection circuit with low  
2              input capacitance, suitable for an I/O pad, comprising a  
3              plurality of diodes, stacked and coupled between a first  
4              power line and the I/O pad, wherein during normal operation,  
5              the diodes are reverse-biased, and, when an ESD event occurs  
6              between a second power line and the I/O pad, the diodes are  
7              forward-biased to conduct ESD current.
  
- 1        2. The ESD protection circuit as claimed in claim 1, wherein each  
2              diode is a PN junction diode formed by placing a doped area  
3              of a first conductivity type in a first well of a second  
4              conductivity type, a deep well of the first conductivity type  
5              formed under the first well to isolate the first well from  
6              a substrate of the second conductivity type.
  
- 1        3. The ESD protection circuit as claimed in claim 2, wherein the  
2              first well is surrounded by a second well of the first  
3              conductivity type.
  
- 1        4. The ESD protection circuit as claimed in claim 2, wherein the  
2              first conductivity type is N type, and the second  
3              conductivity type is P type.
  
- 1        5. The ESD protection circuit as claimed in claim 1, wherein the  
2              ESD protection circuit further includes a power-rail ESD  
3              clamp circuit, set between a first power line and a second  
4              power line, the power-rail ESD clamp circuit being turned on  
5              to conduct ESD current when an ESD event occurs.

- 1       6. The ESD protection circuit as claimed in claim 5, wherein the  
2       power-rail ESD clamp circuit includes a substrate-triggered  
3       MOS of the first conductivity type, the substrate-triggered  
4       MOS including two source/drain regions and a substrate, the two  
5       source/drain regions coupled to the first power line and the second  
6       power line respectively, the substrate node biased with  
7       suitable current to trigger a bipolar junction transistor  
8       parasitizing in the substrate-triggered MOS, and conducting  
9       ESD current when an ESD event occurs.
- 1       7. The ESD protection circuit as claimed in claim 6, wherein the  
2       substrate-triggered MOS includes a gate applied with a first  
3       bias voltage to keep the substrate-triggered MOS off during  
4       normal operations.
- 1       8. The ESD protection circuit as claimed in claim 6, wherein the  
2       gate is applied with a second bias voltage to speed up the  
3       turn-on rate of the substrate-triggered MOS when an ESD event  
4       occurs.
- 1       9. The ESD protection circuit as claimed in claim 6, wherein the  
2       substrate-triggered MOS is formed in a first well of a second  
3       conductivity type, a deep well of a first conductivity type  
4       being formed under the first well to isolate the first well  
5       from a substrate of the second conductivity type.
- 1       10. The ESD protection circuit as claimed in claim 9, wherein the  
2       first well is surrounded by a second well of the first  
3       conductivity type.

1       11.The ESD protection circuit as claimed in claim 5, wherein the  
2           power-rail ESD clamp circuit includes an ESD detection  
3           circuit to detect the occurrence of the ESD event.

1       12.The ESD protection circuit as claimed in claim 1, wherein one  
2           of the diodes is a MOS diode with a gate coupled to a  
3           source/drain of the MOS diode.

1       13.The ESD protection circuit as claimed in claim 1, wherein the  
2           diode includes a PN junction diode formed by a PN junction  
3           between a source/drain and a substrate of a MOS.

1       14.The ESD protection circuit as claimed in claim 13, wherein  
2           the gate of said MOS is coupled to the first power line.

1       15.The ESD protection circuit as claimed in claim 13, wherein  
2           the gate of said MOS is coupled to another source/drain of  
3           the MOS.

1       16.The ESD protection circuit as claimed in claim 13, wherein  
2           the MOS is PMOS.

1       17.The ESD protection circuit as claimed in claim 13, wherein  
2           the MOS is NMOS.

1       18.A power-rail ESD clamp circuit, suitable for an integrated  
2           circuit, coupled between two power lines, comprising:  
3           a substrate-triggered MOS, including:  
4            a gate;

5           two source/drain, respectively coupled to two power  
6           lines; and  
7           a substrate; and  
8           an ESD detection circuit, providing a bias current to the  
9           substrate of the MOS, and a bias voltage to the gate of the  
10          MOS element to trigger the MOS and conduct ESD current when  
11          an ESD event occurs.

1       19. The power-rail ESD clamp circuit as claimed in claim 18,  
2       wherein the power-rail ESD clamp circuit further comprises  
3       a voltage clamp circuit coupled between the gate and one of  
4       the two power lines to limit the bias voltage.

1       20. The power-rail ESD clamp circuit as claimed in claim 19,  
2       wherein the voltage clamp circuit is formed by one diode  
3       forward-biased when the ESD event occurs.

1       21. The power-rail ESD clamp circuit as claimed in claim 19,  
2       wherein the voltage clamp circuit is formed by a plurality  
3       of stacked diodes forward-biased when the ESD event occurs.

1       22. The power-rail ESD clamp circuit as claimed in claim 19,  
2       wherein the voltage clamp circuit is formed by a Zener diode  
3       reverse-biased to clamp the bias voltage at a breakdown  
4       voltage when ESD event occurs.

1       23. The power-rail ESD clamp circuit as claimed in claim 18,  
2       wherein one of the two power lines is a high voltage power  
3       line, the other is a low voltage power line, and the  
4       substrate-triggered MOS is an NMOS.

1       24. The power-rail ESD clamp circuit as claimed in claim 18,  
2           wherein said ESD detection circuit comprising:  
3           an RC-based circuit for detecting the ESD event; and  
4           a driver controlled by the RC-based circuit, for driving the  
5           gate and the substrate of the substrate-triggered MOS.

1       25. The power-rail ESD clamp circuit as claimed in claim 24,  
2           wherein the RC-based circuit includes a resistor and a  
3           capacitor, connected in series between the two power lines.

1       26. The ESD clamp circuit between power lines as claimed in claim  
2           24, wherein the driver includes an inverter, having an output  
3           node coupled to the gate and the substrate of the  
4           substrate-triggered MOS.